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THE USE OF AERIAL PHOTOGRAPHS IN MAPPING GROUND CONDITIONS AND CRUISING TIMBER IN THE MISSISSIPPI RIVER BOTTOM LANDS

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* - This series of publications releases data gathered in connection with investigations being carried on at the Southern Station. The information contained in them is subject to correction or amplification following further investigations. - Editor

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Aerial photography in effect takes the user of the photographic prints to a lofty elevation and gives him a bird's-eye view of the country with which he is concerned. In addition it gives him a permanent, mechanically perfect record of everything he has seen from that height. It reproduces the roads, streams, individual trees, houses, the boundaries of forest areas, every crook and turn of the rivers and all the roads that may be encountered in conducting ground work in the area. In agricultural areas property lines can frequently be identified on the pictures by the fence rows which have grown up to brush and weeds, and by the differences in land use which so often coincide with ownership boundaries. Aerial photographs are very nearly true to scale. Distortion, even at the edges, usually is not more than 2 chains (132 ft.) per mile. This record that can conveniently be carried into the woods is worth much to the man who has timber to map or cruise or other forestry work to do.

The accompanying photograph, Figure 1, is a fair sample of a series covering the whole of the alluvial bottom lands of Mississippi. These photographs were made in 1931 by the Army Engineers for mapping purposes, and were taken at an altitude of 12,000 feet. The photograph reproduced here plainly shows that major features of the earth's surface can be readily distinguished on photographs taken vertically at 12,000 feet and that cleared land, forest land and water can be recognized with little chance of error.

Use of aerial photographs in identifying forest types and conditions

Some photographs of this series were used experimentally by the Southern Forest Experiment Station as a means of classifying forest areas into certain broad groups on the basis of size of timber and density of

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stand. This work was done without the use of a stereoscope or other specialized equipment. When the pictures were taken to the field for a check of the work, it was found that the stands classified on the photograph as "large trees, medium-to-well-stocked" included not only virgin but cut-over forests. This of course is because large trees of inferior grade or species remained on the cut-over land in sufficient numbers to constitute a forest in themselves. It was found that stands classed as "young trees, medium-to-well-stocked" included areas poorly-stocked with timber but crowded with brush dense growths of vines and other economically worthless undergrowth. Thus it proves to be no simple matter to look at the forest areas on the photograph and say confidently, "This is old-growth timber; this is cut-over; this is second-growth." Still more difficult is the task of determining from the photograph whether the timber type is sweet gum and red oak, over-cup oak-pecan, or some other mixture of species.

It is true that familiarity with a region where aerial photographs are available results in an increase in the accuracy with which forest conditions and types can be identified on the photographs. Whatever the extent of the experience, however, it will usually be impossible to accurately map the type and condition of all of the forest appearing on a given photograph taken at an altitude of 12,000 feet without a certain amount of ground work. Skilled observers can usually identify on aerial photographs such distinctive forest types and conditions as fringes of pure cypress along lake margins, some of the cut-over areas, and dense stands of large-sized timber. But for the forest as a whole it is necessary to check office interpretations of the photographs against actual ground examination. On pictures taken at a lower altitude it should be possible to determine forest conditions and forest types more accurately, but to decrease the altitude sufficiently for condition and type to become generally distinguishable would materially increase the cost of the aerial photographs.

Use of aerial photographs as an aid to ground work

Although forest conditions and types cannot be accurately distinguished on the photographs without extensive checking on the ground, aerial pictures do save the mapper and cruiser much work and expense. When the pictures are used in connection with ground examination a glance at a stand of timber from a nearby road or trail is often all the ground work that is necessary for mapping purposes. To ascertain the boundaries of the same stand without the photographs would require extended travel at many times the cost of aerial photography.

Aerial photographs are not maps

In using aerial photographs it is important to bear in mind that the photograph is not a map, but simply a vertical view of the earth's surface. The earth's features are shown not by standardized symbols but only as they appear from a high elevation, and intelligent, trained

interpretation is necessary to make the best use of them. Such records, unsupplemented by ground work, cannot be expected to fill every map need but they can be made a very valuable complement to both office and field equipment. If a given mapping job begins with aerial photography, nearly every succeeding step in the preparation of the finished map will be simplified and expedited. It should be made clear that although aerial photographs are not maps, they may serve as such, and that they can be made to serve as the basis for maps of many descriptions.

Features such as boundaries of forest and non-forest land and of water, and the location of roads and streams can be transferred directly from the photographs to a map in approximately correct location. The map showing only those features that are desired for a given purpose will be more useful for that purpose than the photographs. For the purpose of subsequently mapping features not shown on the first map and for such administrative and utilization jobs as timber-cruising, road-building, fire-fighting, trail location, or logging, the unaltered aerial photograph should prove invaluable.

Mapping from aerial photographs by use of overlays

A convenient method of using the photographs for mapping work is to place a tracing cloth or transparent paper over the photograph. Onto this overlay the location of roads, timber-land boundaries, and streams can be readily transferred and properly identified by appropriate symbols without defacing the photograph.

Figure 2 shows a map prepared in this way from the accompanying photograph. Comparing the map and the photograph from the standpoint of their value as aids to woodsmen working in the area it is noted that buildings, individual trees, minor roads and much other detail appears on the photograph, but not on the map. For the purpose of the map this information may not be necessary, but for future uses that may develop, it may prove invaluable.

To prepare a map of equal accuracy and detail with ground work alone would cost many times the cost of aerial photography. For photographs with 60% overlap in flight and 25% side overlap between flights, taken at an altitude of 12,000 to 18,000 feet the cost in 1933 was as low as $4.00 per square mile, or less than two thirds of a cent per acre. The ground work required to prepare such a map from the aerial photographs should not cost more than two cents per acre.

A map of equal accuracy but with much less detail might be prepared without the aid of aerial photography at a minimum cost of three to five cents per acre, but the preparation of a record equal in detail and accuracy to the aerial photographs would cost many times that amount.

Scale of photograph

In using aerial photographs as a part of field equipment for mapping and other work, the determination of the scale is an important consideration. For an individual photograph this can be determined by comparing the ground distance with the photograph distance between two points that can be identified on the photographs. The scale of photographs taken on a single "flight", i.e., one strip of pictures, should vary but little. This depends, of course, upon care on the part of the pilot in holding the plane at the same altitude throughout the flight. Between any two "flights" of pictures there may be an appreciable variation in scale. This is largely caused by failure to properly correct altimeter readings for day-to-day changes in barometric pressure. As a result of this, it is necessary to determine the scale of each "flight" of pictures if they are to be of most value to the ground worker. This should be done for a picture near each end of the "flight" and for intermediate pictures along the "flight". Once determined for a given "flight" the scale should be shown on each picture taken in the "flight", and if desired the standard deviation or other statistical measure of accuracy can be determined and posted with the scale on the photographs. If appreciable variation is found, it is an indication of poor workmanship on the part of the pilot or to adverse flying conditions. Therefore it is desirable that aerial photography contracts specify maximum allowable variation in the scale of photographs, both within individual "flights" and from "flight" to "flight". The writing of such specifications involves technical knowledge of the problem which the purchaser of aerial photographs may not possess. Therefore, in order to have standards that will insure him a quality of product and still be reasonable from the standpoint of the contractor, standard specifications should be secured from technicians familiar with the work, and should be incorporated in bid specifications.

Various government agencies contracting for aerial photography have such specifications, as do numerous commercial firms.

The scale of the photographs used in the survey of the bottom lands of Mississippi was very satisfactory. It is not believed that prints on a scale smaller than 1/12,000 (one-half inch per mile) show sufficient detail for successful field use. Individual photographs can easily be enlarged or reduced slightly to give a uniform scale for all photographs. For comparing bids it is important that the altitude of flight be stated to prevent the delivery of prints from negatives taken at a greater altitude and smaller scale but enlarged to the specified scale.

Estimated value of aerial photographs for general forest work

Based upon the use made of aerial photographs on the Forest Survey in the Mississippi Delta, and upon familiarity with the map needs of general forest work, it is the opinion of the writer that from the standpoint of economy, efficiency and convenience there is adequate need for making aerial photography a primary project in organizing a program of acquisition, protection, administration and management of large forest areas.

Use of stereoscope and other equipment

The use of specialized equipment for reading and interpreting aerial photographs is not covered in this report, which is based on such use as might be made of aerial photographs without special equipment. Reports of the success with which specialized stereoscopic equipment is being used for the preparation of topographic maps and even for estimating timber[1] indicates that the uses reported here are crude and elementary. Consideration of the more refined uses should not, however, prevent the full recognition of the value of aerial photography for such rough uses as are described herein. They are field uses to which the unaltered prints can actually be put in doing the old tasks in essentially the same old way. The astonishing progress that has been made in the use of aerial photography for doing these tasks in entirely new ways is left to be reported upon by those more familiar with it.

SUMMARY

Experience in using aerial photographs taken at elevations of 12,000 to 18,000 feet on a survey of the forests of the alluvial bottom lands of the Mississippi indicates:

1. - Without special stereoscopic equipment and supplemental ground work, aerial photographs cannot be depended upon for accurately identifying forest types and conditions.

2. - As an adjunct to ground work aerial photographs are invaluable in saving time, effort and money.

3. - Aerial surveys at a cost of less than two-thirds of a cent per acre show more detail than ground surveys at many times this cost.

4. - Uniformity in the scale of the photographs is an important consideration. This should be a major objective of the photographers. Definite standards of uniformity should be specified in the preparation of contracts for aerial photography.

5. - The scale of photographs for forest mapping and similar work should not be smaller than 1/12,000.

6. - Judging from their usefulness in surveying work it is believed that aerial photographs can contribute substantially to the economical and efficient acquisition, protection, management, and utilization of forest properties.

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[1] See: Neuman, C. "Beitrag zur Vorratsermittlung aus Luftmessbildern," Zeitschrift fur Weltforstwirtschaft 1(2-4):168-232, 1933-34, (English Summary - No. 4, p. 232, January, 1934); and Jacobs, M.R. "Die Luftaufnahme im Dienste der Forsteinrichtung mit Forschaegen zu ihrer Weiterentwicklung, insbesondere in unentwickelten Laendern." Publication of the Institute of Foreign and Colonial Forestry in the Tharandt Forest School No. 1, July 1932. (English Summary)

Yazoo River bottom land, near Minter City, Mississippi. Land clearing has followed the long, curving ridges of the alluvial plain. As a result fields appear as long narrow ribbons on the aerial photograph. Compare this picture with Figure 1, a map prepared from it.

The scale of this picture is approximately *3.3 inches per mile.

LEGEND

==== Roads ■ Houses ═══ Levees

Forested areas Improved land

Scale : 3.3 inches = 1 mile